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Review

Can Intelligence Testing Inform Educational Intervention for Children with Reading Disability?

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Abstract: This paper examines the value of intelligence testing for the purpose of informing us how best to intervene with children with reading disability. While the original function of IQ testing was to ascertain whether a child was capable of profiting from schooling, there are many who now claim that cognitive assessment offers a range of diagnostic and prescriptive functions which can help teachers in delivering effective educational programs. This paper interrogates such assertions in relation to the assessment of IQ, cognitive strengths and weaknesses, executive functions, and the use of dynamic testing/assessment. The paper concludes that current evidence indicates that cognitive measures have limited relevance for instructional planning, and cognitive training programs have yet to show sufficient academic gains. For these reasons, it is recommended that our energies should be directed to the continuing development of powerful forms of academic skills-based instruction operating within a response to intervention framework.

Keywords: intelligence testing; dyslexia; reading disability; executive functions; dynamic assessment

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1. Introduction

For more than a century, psychologists have used IQ measures to estimate individual human intelligence. One main reason for the continued use of these tests is their predictive quality; the test scores are relatively powerful indicators of how individuals will function in school and professional settings. A second reason is that, in theory, these tests make it possible to describe the individual's cognitive functioning. Using these tools, one should be able to detect cognitive strengths and weaknesses and advise teachers upon how to conduct appropriately tailored intervention strategies. However, there is still much debate as to whether such an approach represents the most valuable use of scarce resources. In this article, we shall examine the claims for different approaches to intelligence testing (and IQ profiling) and consider the extent to which the assessment of cognitive processes can inform professional action in addressing reading disability, by far the most common form of learning disability [1].

When first training as educational (school) psychologists our primary focus was upon understanding how to competently administer and score a variety of IQ tests. The detailed appendices with multiple tables and figures reassured us that we were engaged in a highly scientific, rigorous pursuit. The ability to produce a profile of factor and subtest scores, in which the child's strengths and weaknesses could be highlighted, served to strengthen our belief that we were undertaking a powerful form of intellectual assessment that could offer much to our teacher colleagues. Subsequently, our attention was focused upon writing detailed reports for parents, schools and other professional colleagues in which we sought to convert this recondite psychometric knowledge into helpful description and recommendation.

Gradual disillusionment with the value of these tests for the purposes of guiding educational action only came later once we had mastered the technicalities of psychometric testing. Of course, these measures had their uses. One could, for example, report that James, who was presenting with disruptive behavior, had scored 88 on an IQ test, and point out that his verbal performance was weaker than that for spatial items. One could add that he lived in a socially disadvantaged area where his language experience was likely to have been impoverished. Another hypothetical child, Sally, referred because of poor progress in reading, gained a full IQ score of 118. While strong on most items she performed close to the mean on a speed of processing measure and a digit span subtest. Such information would be of interest to teacher colleagues, perhaps changing their overall view of the child. Indeed, there have been rare occasions when we have used IQ scores as the primary means to challenge gross misunderstandings of a child's intellectual ability. However, when it came to recommending specific educational interventions, particularly in the area of reading development, the limitations of IQ testing became all too apparent.

2. The Resilience of Discrepancy Testing

Historically, a key task of intelligence testing for children with learning disabilities was to assess whether there was a significant discrepancy between their intellectual and their academic achievement. In the US, this has been an important criterion for diagnosing whether the child could be diagnosed as having a learning disability. In the UK, the discrepancy model was (and, remarkably still is in the work of some psychologists) used to determine whether a child can be diagnosed as dyslexic. Thus, high IQ poor readers were held to be dyslexic, whereas those with low IQs were considered to be poor readers whose decoding problems were a result of low level of cognitive functioning.

While the discrepancy model can be challenged on the grounds that it introduces measurement error [2], its use has been primarily discredited because supposed differences between high and low IQ poor readers have not proven to be meaningful in educational terms. More recently, findings from neurophysiological studies have indicated no support for the argument that there are different aetiologies for IQ discrepant and nondiscrepant groups in relation to phonological awareness, a very influential aspect of reading disability [3,4].

The discrepancy model has proven to be of little value in assisting with educational decision-making. Findings from a series of meta-analyses and scorecard reviews [3–7] led to a dismissal of the suggestion that IQ-achievement discrepancy is an important predictor of who will make decoding-related gains (see also [8,9]). Similarly, there is insufficient evidence to support the claim that IQ can be used to identify which poor readers will best respond to targeted reading intervention [10]. Thus, in two meta-analyses, Stuebing *et al.*) [6,7] concluded that IQ had minimal predictive power in relation to children's response to reading intervention. Such a contribution could hardy justify the costs of such assessment, particularly when it is clear that a simple baseline assessment of word reading skills represents "…a shorter task with a much stronger relation with outcome" ([7], p. 45).

In trying to find some educationally prescriptive benefits from IQ testing, some have sought to identify various subtest profiles which may shed light on children's particular needs [11]. A widely employed measure at the end of the last century was the ACID profile in which low scores on arithmetic (A), coding (C), information (I) and digit span (D) subtests from the Wechsler Intelligence Scales for Children were considered to be indicative of dyslexia [12]. A variant of this (the SCAD (Symbol search, Coding, Arithmetic, Digit span) profile) where the Information subtest was replaced by the Symbol Search was advocated by Kaufman [13]. If, for example, a poor reader's scores on these subtests were found to be significantly poorer than for the other measures, he or she was considered to show evidence of a dyslexic profile.

Although children who struggle with reading tend to score poorly on these subtests the incidence of the overall ACID profile is typically low [14–16]. Ward *et al.* (1995) [15], for example, found an ACID incidence rate of 3.9% of those with an IQ-reading discrepancy; a small proportion that has little clinical or educational value. IQ profiling of this kind is now generally agreed as having little value when assessing children with reading difficulties in particular [15–19] or learning difficulties more widely. While much of this work has focused upon English, a language with a highly opaque orthography, similar findings have resulted for Finnish [20] and Spanish [21], both of which employ more regular (or transparent) orthographies.

Stanovich (2005) [22] has explained why the emphasis upon IQ discrepancy is of little value for understanding reading disability:

"1. The primary subcomponent of reading that is problematic for children with severe reading problems is word recognition.
2. The primary psychological process underlying the word-recognition difficulties of reading disabled individuals is a problem in phonological coding due to weak segmental language skills.

3. Both the distal processing problem in the phonological domain and the proximal word-recognition problem can in part be remediated with intensive intervention.

The problem for the discrepancy assumption ... is: none of these facts correlate at all with IQ!" (p. 104) (emphasis as in original).

Given the weight of evidence demonstrating the lack of utility of the discrepancy model for diagnosing dyslexia/reading disability, it is puzzling [22] that it continues to figure strongly in the understanding of various stakeholder groups: teachers and school psychologists [23,24], researchers [25,26] and parents. Its use as a key diagnostic criterion of dyslexia continues despite the explicit statements of pro-dyslexia lobby groups that dyslexia (as they understand this term) operates across the full IQ range.

Elliott and Grigorenko (2014) [27] have sought to explain this strange phenomenon. They outline eight reasons why IQ/reading discrepancy continues to be used by many clinicians for diagnosing dyslexia (and other developmental disabilities) despite all evidence on the contrary:

1. The discrepancy mode has been dominant for so long [28] that it is has become steeped in everyday understandings that are difficult to break;
2. Some researchers argue that dyslexia should be unexpected on the basis of functioning in other areas (e.g., [29]). Such a judgement would naturally spring from an IQ discrepancy;
3. Research studies of reading disability often select participants whose IQ scores are within the average range or above. For some, the primary reason for this is that avoiding the inclusion of those with particular cognitive difficulties may help be helpful when identifying underlying cognitive mechanisms associated with reading difficulties [30];
4. Some argue that despite the flaws involved, these are still preferable to existing alternatives. Thus, Elbeheri and Everatt (2009) [31] argue that other indicators are still not sufficiently robust and until these "…are fully explored and reliably measured, the arguments for using IQ tests as a basis of indication will be difficult to refute" (p. 30);
5. In many countries, IQ test scores are key in determining eligibility for additional education services;
6. There is a relatively strong association between IQ and reading comprehension [32,33];
7. IQ tests are restricted to appropriately qualified professionals, are iconic images of psychological practice, and, for many, are an important means of reserving and maintaining professional influence and status. As one psychologist states, "...the intelligence test is our stethoscope, like it or not" ([34], p. 54).
8. Many poor readers are understandably concerned to ensure that their reading difficulties are not perceived by others as indicative of low intelligence. The hurt and humiliation that are often experienced by struggling readers, as a result of the perceptions and misunderstandings of others [35] are such that a diagnostic label that not only decouples intelligence and reading ability, but is also suggestive of higher-level intellectual functioning, will be highly attractive.

To this list can be added a further reason:

9. Assessments of dyslexia/reading disability are often conducted by those whose experience involves the use of testing rather than involvement in approaches to tackling severe reading

disability. As noted below, the debate has moved away from IQ to cognitive profiling in recent years.

In recent years there has been something of a shift in clinical practice from IQ testing to that of cognitive assessment, often involving a search for "patterns of cognitive strengths and weaknesses (PSW)" [36,37]. Within this framework, a number of different models has been advocated [38–40].

It is important to emphasize that current debates concerning cognitive assessment and learning difficulties typically concern:

(a) whether the individual should be diagnosed in some way (e.g., as learning disabled, having a specific learning disability, or as dyslexic) which differentiates them from others with more global difficulties (often referred to as "slow learners"). The use of such terms varies from one country to another;
(b) how the individual is likely to respond when given extra assistance;
(c) the ways by which the individual's cognitive profile can be employed to inform closely related interventions.

In 2010, the Learning Disabilities Association of America published a white paper purporting to provide an expert consensus on the identification and treatment of learning disability [41]. The white paper argued that diagnosis should be based upon examination of the individual's profile of cognitive strengths and weaknesses. Such an approach, "…makes the most empirical and clinical sense" ([41], p. 228).

Despite these confident assertions, others have expressed considerable doubts as to their scientific legitimacy [42]. Thus, cognitive profiling approaches have been criticized for questionable reliability leading to an inability to provide scientifically rigorous diagnoses [43–46]. Miciak *et al.* (2014) [45] examined the utility of two common PSW methods, (a) the concordance/discordance method [38] and (b) the cross-battery assessment method [39]. It was found that a relatively low proportion of participants was identified as learning disabled, and there were considerably differences in who was flagged up by the two approaches. Furthermore, there was little difference in the academic performance of those who met, or did not meet, the learning disabled criteria, thus posing questions about the external validity of the PSW model. Given these findings, Miciak and his colleagues [45] concluded that it would be difficult to justify the significant resource implications that follow on from widespread use of PSW methods. A similar study, this time with second grade children [46] arrived at broadly similar conclusions.

The popular notion of a learning disability as something indicated by "unexpected underachievement" [47] throws up a number of complex questions about its value for guiding practical action in relation to assessment, classroom intervention and equitable resourcing (see also, [48]). For many, unexpectedness is demonstrated by particular weaknesses within a "sea of strengths". However, then, how would one represent those children whose cognitive profiles are relatively flat [49]? To avoid the use of the learning disabilities label for such children is quite rightly considered to be "absurd" ([50], p.52).

3. IQ *versus* Executive Functioning

It is possible to argue that executive functions have become the new IQ. Executive functioning is employed as an umbrella term to describe top down cognitive processes that are used for the completion of a task, rather than for situations which require an automatic, instinctive response. While there is no definitive list of executive functions, and for some there is a degree of overlap with what have been termed "learning related behaviors" [51] core executive functions would appear to involve (a) the capacity to inhibit one's actions appropriately (to exercise self-control and to control one's selective attention); (b) working memory; and (c) cognitive flexibility [52]. However, operational definitions and measurements of executive functions often vary greatly [53].

It would seem obvious that executive functions of this kind are related to high quality learning. Clearly, if there are significant attentional or self-regulatory difficulties it is unlikely that an individual's learning will be optimal. This assertion has been supported by evidence from research studies suggesting a relationship between executive functions and performance in literacy [54,55], mathematics [51,56] and science [57]. However, it is important to note that, for example, executive functioning is not a key predictor of reading disability [58] with other factors such as a family history of reading difficulty, phonological awareness, and letter knowledge proving to be more important. An important consideration concerns the uncertainty as to whether the relationship between executive function and academic achievement can be shown to be causal, rather than correlational [53].

Any good teacher will surely recognize the importance of providing an educational environment that will maximize children's capacity to manage and regulate their learning in as productive a fashion as possible. Similarly, educational (school) psychologists investigating children's learning difficulties have typically sought to gain understanding of the individual's approach to learning and problem-solving. While such insights typically complement a derived IQ test score, tests of short-term and working memory, and various forms of information processing, have long been integral to IQ testing. It would appear, therefore, that assessing an individual's executive functioning is hardly contentious, even if, in some ways, perhaps, we are talking about old wine in new bottle.

While it would seem helpful to identify various components of learning that may help teachers in their attempts to foster high quality learning, we must exercise caution when championing the potential benefits of cognitive training programs. Concerns as to whether identifying weak cognitive processes (from IQ tests or other similar measures), and training these directly, can result in improved academic attainment, apply equally to executive functioning. Thus, while Wass (2015) [59] and Diamond [52,60] assert that cognitive training programs are powerful means to improve executive functioning, others are less readily persuaded [61]. Furthermore, as is the case for those who advocate training programs to directly address cognitive weaknesses identified by psychometric testing, there is insufficient evidence that training executive functions will boost academic achievement of those with learning difficulties.

Much recent energy has focused upon the training of working memory in the hope that this will impact upon academic performance. While there is evidence that performance gains can be achieved within experimental settings [62,63] there has been significant criticism of the design and statistical analyses of many intervention studies [64,65]. It is also conceivable that gains on cognitive measures merely reflect practice effects and/or test strategy refinement [66,67]. Furthermore, there is limited evidence of transfer of working memory gains within experimental settings to classroom environments [63,65]. More problematically, perhaps, there is even less evidence that memory training programs can help overcome the literacy difficulties of reading disabled children [61,68,69]. Neither is there strong evidence to support the efficacy of classroom-based working memory interventions geared to improve academic skills [70]. Similarly, there appears to be insufficient evidence to support claims that attention-training programs can result in academic gains for those with attention difficulties. Indeed, given the significant opportunity costs involved it would seem preferable to use available resources and time to focus upon academic interventions [53,61,71].

At the current time, it would seem valuable to recognize executive functioning as an area that is ripe for further research. At the same time, however, we should avoid offering prescriptive recommendations for practice, on the basis of claims about the training of executive functions, that currently lack adequate scientific support.

4. Predicting Academic Progress

Whatever classification systems and diagnostic labels are employed, educationalists are often concerned to determine how likely a given child is to profit from intervention. The key question here is whether assessing cognitive processes, as advocated by Hale and colleagues (2010) [41], will provide sufficient information, above and beyond that yielded by traditional educational assessment, to justify its use. The evidence to support this stance appears not to be powerful. Fletcher and colleagues (2011) [72], for example, found that while children's response to a focused small group intervention could be partially determined by cognitive assessment, the crucial factor seemed to be the severity of impairment in each child's reading skills. The additional contribution provided by the cognitive measures did not appear to justify the costs involved. Recent studies [42,45,73] have similarly concluded that there is minimal value in assessing cognitive characteristics for the purpose of predicting how children will respond to intervention. Put simply, the additional information such assessments can provide, above and beyond that yielded by baseline academic assessment or curriculum based or embedded measures [74] appears not to be worth the investment of resources that is required.

Stuebing *et al.* (2015) [73] undertook a meta-analysis of 28 studies of young children (third grade and younger) in order to answer the question: What is the magnitude between various baseline child cognitive characteristics and responses to reading intervention? Their conclusions were that effect sizes were small and not able to improve prediction in a clinically meaningful way. Furthermore, it was adjudged that administering cognitive measures to all children who might be at risk of reading disability was unlikely to prove cost effective.

As indicated above, it is important to differentiate between the use of cognitive variables in order to inform predictions about students' likely future progress, and their potential to guide appropriate forms of targeted educational intervention: one should not confuse identification (for example, of learning disability status) with treatment [75].

Recognizing the increasing influence of response to intervention (RTI) models, proponents of cognitive testing have argued that this may be particularly valuable for those who do not appear to gain from RTI initiatives. According to Decker, Hale, and Flanagan (2013) [36], such information helps guide the formulation of targeted, individualized interventions. Arguing for the value of gaining an individualized picture from cognitive testing, Reynolds and Shaywitz (2009) [76] contend that:

> "One of the major purposes of a comprehensive assessment is to derive hypotheses emerging from a student's cognitive profile that would allow the derivation of different and more effective instruction. By eliminating an evaluation of cognitive abilities and psychological processes, we revert to a one-size-fits-all mentality where it is naively assumed that all children fail for the same reason…At the current stage of scientific knowledge, it is only through a comprehensive evaluation of a student's cognitive and psychological abilities that we can gain insights into the underlying proximal and varied root causes of reading difficulties and then provide specific interventions that are targeted to each student's individual needs" (pp. 46–47).

Critics of this approach (e.g., [3,49,77,78] have argued that neither they, nor the proponents of cognitive profiling, have been able to provide empirical support for the suggestion that such assessments can guide differentiated interventions. Gresham [77] noted that there were no data-based studies (other than individual case studies) to support this position, while hundreds of studies in many areas of learning had failed to show such a phenomenon [79,80]. Compton, Fuchs *et al.* (2012) [81] similarly suggest that empirical support for interventions tied to a given individual's unique cognitive strengths and weaknesses is, "... equivocal at best" (p. 79). Dismissing the idea that cognitive profiles can be valuable for planning intervention, Fletcher (2009, p. 506) [82] asserts:

> Despite claims on the contrary (Hale *et al.*, 2008) [37] there is little evidence of Aptitude x Treatment interactions for cognitive/neuropsychological skills at the level of treatment or aptitude ([83], pp. 28–29). The strongest evidence of Aptitude x Treatment interactions is when strengths and weaknesses in academic skills are used to provide differential instruction [84].

Kearns and Fuchs (2013) [85] explored the suggestion that educational skills-based instruction is not effective for all children and that other approaches might have something additional to offer. Noting that criticisms of cognitively focused instruction were sometimes based upon studies conducted before more modern understandings and practices were derived, they sought to bring knowledge up to date by reviewing 50 studies. In each of these, cognitively focused instruction was employed either in isolation, or alongside academic interventions, to help children who were struggling with their learning. Their findings indicated that a minority of the studies reviewed showed that cognitive interventions were effective, and this number decreased when academic instruction did not feature as part of the intervention. Findings were rendered rather more problematic by the use of poor experimental design in a number of cases, with stronger effects noted in weaker studies.

The key conclusion here is that whether we consider measures of IQ, executive functioning, or other cognitive processes, in those situations where children present with reading difficulties, current evidence continues to strongly support Vellutino *et al.*'s (2004) [33] recommendation that we should focus upon educational, rather than cognitive, interventions [86,87]. However, to accept the argument that practitioners should change the primary focus of assessment from cognitive testing to academic progression is to introduce a threat to many professionals schooled in the psychometric tradition who may lack high-level expertise in curricular and pedagogic practices. Such professionals may, therefore, be discomfited by the conclusions of [33] that because "intelligence tests have little utility for diagnosing specific reading disability" (p. 29) clinicians should:

> "…shift the focus of their clinical activities away from emphasis on psychometric assessment to detect cognitive and biological causes of a child's reading difficulties for purposes of categorical labelling in favor of assessment that would eventuate in educational and remedial activities tailored to the child's individual needs" (p. 31).

5. Dynamic Approaches to Cognitive Testing

When clinicians employ standardized intelligence tests in educational settings their primary purposes are usually, as we have described above, to predict and describe the likely academic progress of the child, offer a diagnosis, or describe strengths and weaknesses in cognitive abilities. Most tests and test scores have a *static* nature. A static test, usually employing a set of standardized instructions prescribed in the manual, is characterized by its absence of contingent feedback to the child. Test scores are aggregated and global test or factor scores are interpreted in terms of the (cognitive) abilities of the child. Scores on static instruments are indicative of the child's actual level of performance(s) reflecting learning that has taken place in the past [88].

A common criticism of the value of IQ tests, therefore, is that they seem to emphasize the products of learning rather than psychological processes [89] and, as a result, test scores can shed little light upon how individuals learn, or fail to learn. Indeed, Binet, the father of intelligence testing, was convinced by 1916 that intelligence test scores (including those from his own test), did not provide an appropriate picture of the child's ability to learn. This may be one key reason for their seeming inability to offer sufficiently valuable guidance for instructional practices [90,91]. A further weakness of IQ testing has been that children from less socially advantaged communities, or from minority cultures, are less likely to be able to demonstrate their full potential [92,93]. To address these weaknesses, an alternative approach, dynamic assessment (also known as dynamic testing), has been advocated by a small minority of psychologists.

Dynamic assessment/testing are umbrella terms used to describe forms of assessment in which instruction or intervention are integral aspects of the testing procedure [94–99]. Testees are explicitly provided with training, feedback, or prompts in order to enable them to show their processing and subsequent progress when solving cognitive tasks [88]. While these terms are sometimes used interchangeably, it is useful to follow Sternberg and Grigorenko's formulation [98], and differentiate between *dynamic testing* in which the whole test procedure is transparent, objective and repeatable, and a wider conception of *dynamic assessment* in which testing is paired with clinical and individualized intervention.

The theoretical origins of all dynamic approaches can be traced back to Vygotskian theory, in particular his concept of the zone of proximal development, defined as that area that defines the difference between individual's independent and their guided performance on any activity, and the process of internalization (*i.e.*, internalising the control processes of the guiding person [100]. Vygotsky (1962) [101] considered the assessment of one's potential, by means of the zone of proximal development, to be the principal focus of testing and education.

A dynamic test procedure is primarily aimed at examining how standard training or individualised instruction during the test session(s) can lead to an improvement in a person's performance. While differing in structure, content, and degree of standardization, all such tests have two element in common; children are given hints or training to enable them to show individual differences in progress made during the process of solving a variety of cognitive tasks, and they all emphasize the same defining aspect of intelligence as the ability to learn [102].

A major split between advocates of dynamic approaches concerns the degree of standardization that should pertain. On one side there is the clinical approach originating from the work of Feuerstein, Rand and Hoffman (1979) [103] who argued that because assistance to the child is aimed to induce change, it should be highly individualised and may vary according to the particular perspective of the tester. This process of mediation can yield interesting qualitative information concerning the child's cognitive and affective functioning, but non-standardized training prevents replication of the (case) studies reported. Furthermore, the likelihood of test-retest-reliability is highly questionable [98,104]. More recent descriptions of this approach, showing how both standardization of procedures and research designs have improved since the seminal 1979 work, can be found in [96,99,105,106].

Other proponents of dynamic approaches advocate a strictly standardized approach geared to meet psychometric requirements. This theoretical stream within dynamic testing started with the work of Budoff (e.g., [107,108]). In these lines of research, testees were trained in groups, and all received the same short, classical, standard instructions and training procedures.

Although the work of Feuerstein and his followers has had a seminal influence upon many teachers, psychologists and educationalists, the clinical approach to dynamic assessment has not been widely embraced. Its weakness lies not only in its rejection of what might be deemed to be a transparent and replicable scientific approach to testing but, also, and perhaps more crucially, the inability of its proponents to demonstrate sufficiently how insights from a dynamic assessment can be employed to guide classroom interventions for those experiencing learning difficulties. However, in this latter respect, a similar criticism applies equally to standardized dynamic testing. If group instruction takes place between a pre- and post-test assessment and/or if all children are trained by means of exactly the same, short, training procedure, they will undoubtedly will show more progression in their task solving behavior than untrained peers, but the test scores after training do not fully provide us with information regarding the individual's functioning [102].

Some dynamic testing formats provide children with feedback, prompts or training and focus on how individual differences show up while training is given. Examples are the Adaptive Computer Assisted Learning Test Battery [109] in which a standard set of prompts is given, and progress in learning during the task is registered, and Swanson's (2000) [110] Cognitive Processing Test in which a standard set of prompts focusing on sequential processing strategies related to working memory is provided.

Over time, more sophisticated approaches have sought to assess the individual's potential for learning. One popular dynamic approach, using graduated prompts, developed from the seminal work of Campione, Brown and colleagues [111,112] seeks to assess the amount and type of assistance necessary to achieve pre-specified outcomes and subsequently, the individual's ability to transfer learned principles to novel situations. Here, learning potential is not determined on the basis of the child's best performance on the task but rather, is represented by the inverse of the minimal number of hints or prompts that have proven necessary to reach a specified amount of learning.

Graduated prompting may be seen as a dynamic testing method that is as adaptive as possible, by virtue of its use of different forms of prompting and scaffolding while, at the same time, using standardized protocols for instruction. Grigorenko and Sternberg (1998) [113] described this form of dynamic testing as being primarily focused upon the child's actions rather than on task features, but of course both elements could be combined [102]. Research with this form of dynamic testing has shown that both the number of prompts children need and their posttest scores are good, individual, predictors of future school success (e.g., [98,114]).

In some cases, procedures are fully standardized, are based on detailed task and process analyses, and hint (or "prompt") sequences are hierarchically ordered. However, there is variability to the extent that some approaches are adaptive, that is, hints/scaffolds are provided which are differentially contingent upon the individual's responses (e.g., [115–118]). Testers who seek to use these approaches will typically focus upon changes in problem-solving processes and the use of strategy patterns during testing. The complexity of such approaches, and the large amount of data that can be collected, are such that they lend themselves to computerized forms of testing. Resing and colleagues [118,119] have sought to employ an electronic console and tangible materials with sensors inside. The machine can provide task-related instructions, record the child's responses and, in the light of these, provide a series of graduated prompts and scaffolding techniques. In a series of studies, Resing and her colleagues [118,119] were able to record the use they made of assistance, differences and changes in children's strategy use, verbal explanations of their responses, and solution times. More specifically, such an approach can offer such information as:

- improvements in strategy (into advanced solving procedures such as reasoning, seriation) over time as a consequence of instruction;
- the use of different processes: analytical *versus* heuristic *versus* trial-and-error;
- individual differences in progression; some need a lot of help but still make limited improvement; some improve a lot with the same amount of help; some perform well from the outset;
- differences in the individual's response to various forms of assistance: metacognitive prompts; cognitive prompts, modeling;
- changes in these instructional needs as a result of training gains;
- differences in the time required to plan and to solve the task;
- the way in which such differences emerge;
- variability or constancy in the use of strategies used to solve problems;
- differences in the ways children articulate the processes they have used to help them solve problems;
- changes in the order of groups of children (seen as a measure of potential), based upon scores obtained during the assessment period;
- differences in the child's capacity to transfer learning to new problems.

Sternberg and Grigorenko (2001) [120] queried why "promising" dynamic testing approaches had not been more widely embraced, and it would appear that, in this respect, little has changed in the interim. For some, the low take-up is a reflection of their potentially problematic psychometric properties. For example, Beckmann (2014) [121] asserts that the promise that was "…supposedly not… kept" (p. 309) concerned the difficulty of establishing test validity. He argues persuasively that, given the heterogeneity of the approach, however, validity is a more complex issue than is generally understood.

Elliott (2003) [122] has argued that the primary reason for the failure of dynamic approaches to become more widely established stems, in large part, from the contrasting priorities of psychology researchers and education practitioners. Thus, laboratory-based researchers have often sought to build a superior intelligence test (for the purposes of classification and prediction), or sought to examine the nature of thinking and reasoning processes, rather than seek to develop measures that can help teachers operate more powerful classroom practices that can cater for struggling learners. While it is fair to conclude that dynamic approaches have proven capable of improving prediction, particularly for those who have not grown up under optimal learning conditions [123,124] and have yielded valuable insights into differences in complex problem-solving [118] the current value of dynamic measures for informing classroom practice for identified individuals with learning difficulties remains minimal [115,125]. Although proponents have produced interesting case studies (e.g., [94,96]) these have not proven sufficiently persuasive to justify to the field the adoption of comparatively complex, time-consuming and costly approaches.

A number of researchers have examined how dynamic approaches might aid prediction for the purposes of improving response to intervention (RTI) decision making [95,126]. Interestingly, in contrast to traditional dynamic approaches which tend to employ reasoning tasks that mirror those used in traditional psychometric tools, many of the RTI focused dynamic testing initiatives link the assessment content directly to the academic domain and the related curriculum [127,128]. Thus, the emphasis here upon using curricular material to identify who needs help, appears to mirror the argument for focusing teaching upon deficient academic skills (*cf.* [33]) rather than targeting underlying cognitive processes in the hope that, in turn, this will lead to educational gains. Unlike approaches to learning potential assessment emphasising cognitive processes, it seems likely that the predictive quality of these curricular measures will be highly domain specific [95,129].

6. Conclusions and Recommendations

On occasions it is helpful to undertake cognitive assessment in order to ensure that the intellectual challenge offered to a student is pitched at an appropriate level. Misjudgements can be made by teachers who fail to recognize that a child's present classroom performance may not be indicative of their true abilities. This is particularly true when judgements about a child's intellectual functioning are based upon their reading and spelling performance. IQ tests and suchlike, or various forms of dynamic assessment can be powerful means of rendering salient such misconceptions. However, in relation to undertaking assessment for the purpose of advising on particular forms of classroom intervention to tackle reading disability, whether we are considering IQ tests and subtests, other measures of cognitive processes, executive functions, or clinical or standardized dynamic assessment, we will inevitably encounter similar debates. Ultimately, these focus upon whether going beyond specific academic content and skills to examine underlying cognitive processes, either static or dynamic approaches, will prove sufficiently valuable to justify the significant costs involved. It has been suggested that it may prove fruitful to embed executive functions instruction approaches into explicit academic skills instruction [130] although evidence for the effectiveness of such approaches will not be forthcoming in the immediate future.

Despite the use of multi-tiered response to intervention approaches, there continues to be a small proportion of "treatment resisters" who fail to respond sufficiently to even the most powerful evidence-based approaches [131,132]. In such circumstances, it is understandable that students, parents, teachers and clinicians will search for alternative approaches. The availability of interventions based upon a detailed profile of a student's cognitive strengths and weaknesses would seemingly offer attractive options to many frustrated students and their families However, at the current time, there is insufficient evidence that cognitive training programs can enable non-responsive poor readers to overcome their primary difficulties. Rather, intervention for struggling readers should continue to be directed to academic skills-based instruction operating within a systematic and structured response to intervention framework. However, significant further attention is needed to increase teacher skills and understanding of these approaches [130,133].

Author Contributions

Both authors contributed fully to the writing of this paper.

Conflicts of Interest

The authors declare no conflict of interest.

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